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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/658,732	09/11/2000	Makoto Inai	P/1071-1118	4527

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EXAMINER

BAUMEISTER, BRADLEY W

ART UNIT	PAPER NUMBER
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2815

DATE MAILED: 01/07/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.
09/658,732

Applicant(s)
Inai et al.

Examiner
B. William Baumeister

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2815



-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on Oct 25, 2002
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-10 and 12-15 is/are pending in the application.
- 4a) Of the above, claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-10 and 12-15 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
*See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s). 11 6) ☐ Other:

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DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 2-10 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 2 recites the limitation "the doped layer of the semiconductor structure at the first junction face" in line 2 and "the doped layer of the semiconductor structure at the second junction face" in line 3 (underlines added). There is insufficient antecedent basis for these limitations in the claim.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless -

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

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4. Insofar as definite, claims 1, 2, 4, 6, 8-10 and 15 are rejected under 35 U.S.C. 102(b) as being anticipated by Sawada et al., "A Super Low-Noise AlGaAs/InGaAs/GaAs DC-HFET with 0.15 micron Gate-Length" [Sawada] (previously made of record in IDS #4).

a. Sawada discloses a doped channel composed of n-InGaAs; a doped barrier (or semiconductor structure) composed of n-AlGaAs; and a doped contact composed of n-GaAs. An ohmic electrode is formed on the GaAs contact layer and a Schottky electrode is formed on the barrier layer semiconductor structure.

Claim Rejections - 35 USC § 103

5. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

6. Claims 3, 5 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sawada as applied to the claims above. As explained above, Sawada discloses a DCHFET having a heavily doped channel, barrier and cap layer, wherein the respective junctions are all iso-type heterojunctions. Claim 3 is not anticipated because the claim recites that the layers of the channel/barrier junction and the barrier/contact junction are all doped $1E18$, whereas Sawada-- while also disclosing that these layers are all heavily doped to the same order of magnitude--sets forth specific, slightly higher doping concentrations for the channel, barrier and contact layers of $2.5E18$, $1.5E18$ and $3E18$, respectively.

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a. It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the doping concentrations to the particular doping levels set forth in claim 3 because the doping levels of the Sawada layers are all doped to the same order of magnitude as that claimed, and such minor changes to the doping levels would not produce any unexpected results, but rather constitute an optimization of results readily obtainable through routine experimentation.

b. More specifically, lowering the barrier doping concentration from $1.5E18$ to $1E18$ would merely produce the expected results of proportionally increasing the gate-barrier layer Schottky barrier; decreasing the channel doping from $3E18$ to $1E18$ would slightly reduce both the channel/barrier heterojunction barrier and the carrier-impurity scattering in the channel; and reducing the contact doping from $3E18$ to $1E18$ would proportionally increase the source and drain resistances.

7. Claims 12-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sawada as applied to the claims above and further in view of Inai et al. "Doped Channel HFET..." (Supplied in IDS #5).

a. Sawada teaches all of the limitations set forth above but does not teach the further inclusion of an undoped layer/region disposed between the doped top and the bottom regions of the AlGaAs barrier layer (claim 13), nor that the gate makes Schottky contact particularly to this undoped layer region (claim 14).

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b. Inai discloses a DC-HFET that comprises an n-InGaAs channel; a “semiconductor structure” comprised of an n-AlGaAs intermediate layer adjacent the contact, an undoped AlGaAs barrier layer and a lightly doped n-GaAs layer adjacent the InGaAs channel; and n-GaAs contact double layer. (See pg. 328, 2nd paragraph and FIG 1.) The provision of the undoped AlGaAs layer increases the breakdown voltage because the absence of dopants makes the layer insulating (increases the Schottky barrier); provides increased gate isolation by forming the gate on the undoped AlGaAs barrier layer; and provides large gate to channel separation, thereby reducing the gate capacitance (pg. 328, col. 2). The highly n-doped AlGaAs intermediate layer forms a homojunction with the undoped AlGaAs barrier (i.e., they are the same material, but differently doped). The presence of the intermediate layer reduces the series resistance; “prevents the effect of surface depletion layer between the gate and the source or the drain;” and makes the conduction band profile between the barrier and the cap/contact more continuous (reduces contact resistance) (Pg. 328, cols. 1-2). Inai does not anticipate the cited claims because the n-doped layer of the double barrier is composed of GaAs that is doped to less than 1×10^{17} , as opposed to AlGaAs doped to at least 1×10^{18} as set forth by the claims.

c. It would have been obvious to one of ordinary skill in the art at the time of the invention to have modified the Sawada n-AlGaAs barrier layer by providing an additional undoped layer between the top and bottom portions (or restated, by temporarily stopping and restarting the dopant supply during the growth of the barrier layer) for the purpose of achieving a

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larger breakdown voltage with the undoped, insulating AlGaAs layer while simultaneously reducing the barrier-contact band-discontinuities/resistance as taught by Inai.

d. Alternatively, as Inai teaches that the lightly-doped lower barrier of GaAs is provided so as to achieve enhancement mode operation (pg 328, col. 1, first paragraph), it would have been obvious to one of ordinary skill in the art at the time of the invention to have modified Inai's barrier structure by substituting a doped AlGaAs barrier for the doped GaAs barrier that is adjacent to the n-InGaAs channel, as taught by Sawada, for the purposes of better reducing the gate leakage and increasing the barrier/channel junction conduction-band discontinuity for better carrier confinement in the channel, at least in those applications where enhancement mode operation is not desired.

Response to Arguments

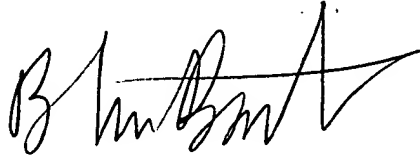
8. Applicant's arguments filed 10/25/2002 have been fully considered but they are either moot in light of the new grounds of rejection or are not persuasive.

a. The Examiner notes that in the present Office Action--just like in the previous Office Action with respect to those claims setting forth that all three portions of the barrier is composed of AlGaAs--the Examiner has acknowledged that Inai does not anticipate the claims, but has taken the position that it would have been obvious to substitute n-AlGaAs for the n-GaAs barrier layer of Inai. Applicant has only argued that Inai does not anticipate the claims, but has not set forth any substantive arguments as to why the claims are not obvious over Inai.

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INFORMATION ON HOW TO CONTACT THE USPTO

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to the examiner, **B. William Baumeister**, at (703) 306-9165. The examiner can normally be reached Monday through Friday, 8:30 a.m. to 5:00 p.m. If the Examiner is not available, the Examiner's supervisor, Mr. Eddie Lee, can be reached at (703) 308-1690. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956.

A handwritten signature in black ink, appearing to read 'B. William Baumeister', with a stylized, cursive script.

B. William Baumeister

Patent Examiner, Art Unit 2815

January 4, 2003